

## Plant Assessment Form

For use with the "Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands"  
by the California Exotic Pest Plant Council and the Southwest Vegetation Management Association  
(Warner et al. 2003)

Printable version, February 28, 2003  
(Modified for use in Arizona, 07/02/04)


**Table 1. Species and Evaluator Information**

<b>Species name</b> (Latin binomial):	<i>Carduus nutans</i> L. (USDA 2005)
<b>Synonyms:</b>	None listed in USDA (2005).
<b>Common names:</b>	Musk thistle, nodding thistle, nodding plumeless thistle, plumeless thistle, chardon penche
<b>Evaluation date</b> (mm/dd/yy):	10/12/03
<b>Evaluator #1 Name/Title:</b>	Dana Backer, Conservation Ecologist
<b>Affiliation:</b>	The Nature Conservancy
<b>Phone numbers:</b>	(520) 622-3861
<b>Email address:</b>	dbacker@tnc.org
<b>Address:</b>	1510 E. Ft Lowell, Tucson, Arizona 85719
<b>Evaluator #2 Name/Title:</b>	
<b>Affiliation:</b>	
<b>Phone numbers:</b>	
<b>Email address:</b>	
<b>Address:</b>	

<b>List committee members:</b>	12/17/03: W. Albrecht, W. Austin, D. Backer, J. Crawford, K. Darrow, B. Phillips, K. Watters 02/17/04: W. Albrecht, W. Austin, D. Backer, J. Crawford, L. Moser, F. Northam, T. Olson, B. Phillips, K. Watters
<b>Committee review date:</b>	12/17/03 and 02/17/04
<b>List date:</b>	02/17/04
<b>Re-evaluation date(s):</b>	

**Table 2. Scores, Designations, and Documentation Levels**

Question		Score	Documentation Level	Section Scores	Overall Score & Designations
1.1	Impact on abiotic ecosystem processes	C	Other published material	<b>“Impact”</b>  <b>Section 1 Score:</b>  <b>B</b>	<b>“Plant Score”</b>    <b>Overall Score:</b>  <b>Medium</b>  <b>Alert Status:</b>  <b>None</b>
1.2	Impact on plant community	B	Other published material		
1.3	Impact on higher trophic levels	C	Other published material		
1.4	Impact on genetic integrity	D	Other published material		
2.1	Role of anthropogenic and natural disturbance	B	Other published material	<b>“Invasiveness”</b>  <i>For questions at left, an A gets 3 points, a B gets 2, a C gets 1, and a D or U gets=0. Sum total of all points for Q2.1-2.7:</i>  <b>16 pts</b>  <b>Section 2 Score:</b>  <b>B</b>	  Something you should know.
2.2	Local rate of spread with no management	A	Observational		
2.3	Recent trend in total area infested within state	A	Observational		
2.4	Innate reproductive potential	A	Reviewed scientific publication		
2.5	Potential for human-caused dispersal	B	Other published material		
2.6	Potential for natural long-distance dispersal	C	Other published material		
2.7	Other regions invaded	B	Other published material		
3.1	Ecological amplitude	A	Observational	<b>“Distribution”</b>  <b>Section 3 Score:</b>  <b>B</b>	
3.2	Distribution	D	Observational		

**Table 3. Documentation**

**Note:** *Carduus nutans* and *C. acanthoides* are often sympatric and readily hybridize (Desrochers et al. 1988, Warwick et al. 1989, Warwick and Thompson 1989, Thompson and Black 1992). Although it is not a regulated plant in Arizona, *Carduus nutans* is listed as a noxious, restricted, or prohibited weed in 24 states including all of the states surrounding Arizona (USDA 2005). *Carduus acanthoides* is listed as a noxious weed in Arizona but is not known to occur in the state (USDA 2005). Most of the studies involving *C. nutans* are in relation to effects on pasture species.

<b>Question 1.1</b> Impact on abiotic ecosystem processes	<b>Score: C Doc'n Level: Other pub.</b>
<b>Identify ecosystem processes impacted:</b> Minor alteration. Inhibits nitrogen fixation.	
<b>Rationale:</b> Although invasive species are often assumed to be associated with soil nitrogen build-up, Wardle et al. (1993 in Zouhar 2002) suggested that some invasive species, such as <i>C. nutans</i> , have the potential to induce long-term decline of soil nitrogen input.	
<b>Sources of information:</b> See cited literature. Because primary/original literature was not reviewed, the category of other published material is used.	

<b>Question 1.2</b> Impact on plant community composition, structure, and interactions	<b>Score: B Doc'n Level: Other pub.</b>
<b>Identify type of impact or alteration:</b> Plant composition and interactions.	
<p><b>Rationale:</b> Capable of forming dense stands (noted in Canada [150,000/ha], Nebraska, and Australia), especially in highly disturbed sites where competition is low or in overgrazed or disturbed pasturelands (Beck 1999, Zouhar 2002) and rangelands (Desrochers et al. 1988, Zouhar 2002). Medd and Lovett (1978 in Zouhar 2002) suggested <i>C. nutans</i> may be sensitive to competition with neighboring plants for light. <i>Carduus nutans</i> does not tolerate interspecific competition (Nebraska: McCarty and Scifres 1969 and Australia: Austin et al. 1985; both in Zouhar 2002). In Nebraska, McCarty and Scifres (1969 in Zouhar 2002) observed that <i>C. nutans</i> plants growing with competition suffered more mortality than those with no competition. One study suggested <i>C. nutans</i> litter may encourage germination of <i>C. nutans</i> seeds (Wardle et al. 1993 in Zouhar 2002).</p> <p>“It is proposed that nodding [musk] thistle is allelopathic at two phases of its development, i.e. at the early bolting stage when the larger rosette leaves are decomposing and releasing soluble inhibitors, and at the stage when bolting plants are drying and releasing insoluble inhibitors. Nodding [musk] thistle seedlings appear to be stimulated by addition of thistle tissues to soil, indicating that thistle plants may weaken pasture and simultaneously encourage recruitment of its own species “(Wardle et al 1993 in Zouhar 2002).</p> <p>Abundant soil nitrogen may favor <i>C. nutans</i> (Medd and Lovett 1978 in Beck 1999), as will adequate moisture and sunlight (Feldman et al. 1968 and Doing et al. 1969 in Beck 1999). The <i>Rhinocyllus conicus</i> (seed head weevil) introduced in Utah as a biocontrol for <i>C. nutans</i> is known to host on native thistles (R. Lee, personal communication, 2004). The presence of <i>R. conicus</i> and the level of predation on native Arizona thistles is not known. Other biocontrol agents have been released in other states and their impact on native Arizona thistles is also not known.</p>	
<b>Sources of information:</b> See cited literature. Because primary/original literature was not reviewed, the category of other published material is used. Also considered a personal communication with R. Lee (Weed Specialist, Bureau of Land Management, Denver, Colorado, 2004).	

<b>Question 1.3</b> Impact on higher trophic levels	<b>Score: C Doc'n Level: Other pub.</b>
<b>Identify type of impact or alteration:</b> Negligible. Impacts cited in primary literature are on livestock.	
<b>Rationale:</b> Foliage is unpalatable to wildlife and livestock, selective grazing leads to severe degradation of native meadows and grasslands as wildlife focus their foraging on native plants (from Tennessee:	

<p>Remaley 2003). <i>Carduus nutans</i> is a problem on range and pastures because it competes with desirable forage, and its sharp spines can hinder movement and deter livestock, and <i>presumably wildlife</i>, from grazing (several authors in Zouhar 2002, Beck 1999). Domestic livestock have been observed consuming flowers and seed heads but do not know the resultant seed viability (Zouhar 2002). R. Lee suggests that the buds are eaten when they are immature and the seeds are not viable. Seeds of <i>C. nutans</i> that have passed through a cow's digestive system are still viable. In most cases, the reproductive structure (bud) of the thistle is eaten by livestock and wildlife when the seeds are not mature enough to be viable (R. Lee, personal communication, 2004).</p> <p>A number of species of birds graze on mature <i>C. nutans</i> seed in Australia (positive effect: Popay and Medd 1990 in Zouhar 2002). Insect and bird foraging occurs on <i>C. nutans</i> in Colorado. R. Lee (personal communication, 2004) suggests that <i>C. nutans</i> seed that passes through a bird may be viable. As a result, birds may be a potential vector for long distance dispersal of <i>C. nutans</i> seed. Holm and others (1997 in Beck 1999) stated <i>C. nutans</i> seeds have been found in the crops of birds and in their nests. In dense stands of <i>C. nutans</i>, hunting of rodents by goshawks or other raptors would be impaired (anecdotal).</p> <p><b>Sources of information:</b> See cited literature; also considered personal communication with R. Lee (Weed Specialist, Bureau of Land Management, Denver, Colorado, 2004).</p>
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<b>Question 1.4</b> Impact on genetic integrity	<b>Score: D Doc'n Level: Other pub.</b>
<b>Identify impacts:</b> None.	
<b>Rationale:</b> Hybridizes with other <i>Carduus</i> species but none of these are native to Arizona. Pollinators may favor non-native thistles over native thistles but no published information documents this.	
<b>Sources of information:</b> Kearney and Peebles (1960) and Desrochers et al. (1988) and Warwick and Thompson (1989) (both in Zouhar 2002).	

<b>Question 2.1</b> Role of anthropogenic and natural disturbance in establishment	<b>Score: B Doc'n Level: Other pub.</b>
<b>Describe role of disturbance:</b> Can invade sites disturbed either naturally or anthropogenically. The disturbance of fire usually requires a seed source to be present in the soil for it to establish post fire.	
<b>Rationale:</b> Spreads rapidly in areas subjected to frequent natural disturbance events (landslides, flooding [Southeast EPPC]). <i>Carduus nutans</i> is most often described as occurring on disturbed sites and waste areas and along roads (Zouhar 2002). Yet populations have occurred elsewhere, outside of heavily disturbed areas (personal observations by Working Group members and R. Lee and L. Walker).	
<p>Role of fire: if <i>C. nutans</i> seeds are present and competition is minimal, fire creates conditions that are favorable (i.e., open canopy, reduced competition, areas of bare soil) to the establishment of <i>C. nutans</i> (Zouhar 2002). Where there is competition either via post fire seeding or pre-existing native seeds in the seed bank, plant invasion by <i>C. nutans</i> has been limited (Floyd-Hanna et al. 1999 and Goodrich 1999 in Zouhar 2002).</p> <p><b>Sources of information:</b> See cited literature and information from the Southeast Exotic Pest Plant Council (EPPC; available on line at: <a href="http://www.se-eppc.org">http://www.se-eppc.org</a>); also considered Working Group member observations and personal communications with R. Lee (Weed Specialist, Bureau of Land Management, Denver, Colorado, 2004) and L. Walker (Weed Specialist, Bureau of Land Management, Arizona Strip, St. George, Utah, 2004).</p>	

<b>Question 2.2</b> Local rate of spread with no management	<b>Score: A Doc'n Level: Obs.</b>
<b>Describe rate of spread:</b> Doubling in less than 10 years.	
<b>Rationale:</b> Because <i>C. nutans</i> is listed in 24 states as a noxious, prohibited or restricted weed (USDA 2005) and thus has some level of enforcement/management to control it, it is unclear what the local rate of spread is with no management. Where it is most invasive (populations in Springerville, Eagar, and	

areas near St. Johns), it is spreading at a rate, which itself may be increasing, greater than 100% in less than 10 years (F. Northam, personal observations, 2003). Considered by land managers in northern Arizona as “can’t keep ahead of it” (Working Group discussions, December 2003).
<b>Sources of information:</b> Working Group discussions and personal observations by (F. Northam (Arizona Department of Agriculture Noxious Weed Coordinator, 2003).

<b>Question 2.3</b> Recent trend in total area infested within state	<i>Score: A Doc’n Level: Obs.</i>
<b>Describe trend:</b> Increasing rapidly, doubling in range in less than 10 years.	
<b>Rationale:</b> <i>Carduus nutans</i> is relatively new to Arizona and has yet to realize its potential. Several suitable habitats in the Flagstaff, Prescott, and Payson areas have not yet been invaded. As a result, <i>C. nutans</i> is expected to expand the number of ecological types that it has invaded in Arizona.	
A variety of mechanical, chemical and biological (several different types of weevils, fly, and rust) control mechanisms have been successful. Although biocontrols <i>Trichosirocalus horridus</i> and <i>Rhinocyllus conicus</i> (weevils) have not been released in Arizona, it is possible that these biocontrol agents have spread into Arizona on their own from neighboring states where they have been released (Zouhar 2002; R. Lee and F. Northam, personal communications, 2003). Several researchers have assessed the effects of <i>R. conicus</i> on <i>C. nutans</i> seed production in different areas of the US and found decreases from 10 to 78% (Surles and Kok 1978 and McCarty and Lamp 1982 both in Beck 1999).	
<b>Sources of information:</b> Based on Working Group discussions and personal communications with R. Lee (Weed Specialist, Bureau of Land Management, Denver, Colorado, 2004) and F. Northam (Arizona Department of Agriculture Noxious Weed Coordinator, 2003); also see cited literature.	

<b>Question 2.4</b> Innate reproductive potential	<i>Score: A Doc’n Level: Rev. sci. pub.</i>
<b>Describe key reproductive characteristics:</b> High reproductive potential.	
<b>Rationale:</b> Based on seed number, production, and viability; ability to self- and cross-fertilize. See Worksheet A.	
<b>Sources of information:</b> See Worksheet A notes and cited literature therein.	

<b>Question 2.5</b> Potential for human-caused dispersal	<i>Score: B Doc’n Level: Other pub.</i>
<b>Identify dispersal mechanisms:</b> Roadways; agricultural/livestock products; logging road and timber related vehicles; horse trails; irrigation ditches.	
<b>Rationale:</b> Along roadsides; livestock and human activities; contaminated in crop seed and hay (Beck 1999, Rees et al. 1996 in Zouhar 2002).	
<b>Sources of information:</b> See cited literature; also considered Working Group member observations.	

<b>Question 2.6</b> Potential for natural long-distance dispersal	<i>Score: C Doc’n Level: Other pub.</i>
<b>Identify dispersal mechanisms:</b> Wind, water, and wildlife.	
<b>Rationale:</b> Wind, water, wildlife, (livestock, and human) activities disperse <i>C. nutans</i> seed (Beck 1999). <i>Carduus nutans</i> seeds are attached to a pappus, but less than 5% of the seed remains attached to the pappus when it breaks off the flower head and floats away on wind currents (Beck 2003). Under controlled, windy conditions (up to 18.5 feet per second [5.6 m/s]), fewer than 1% of <i>C. nutans</i> seeds moved more than 330 feet (100 m), and most seeds were deposited within 160 feet (50 m) of the point of release (Smith and Kok 1984 in Zouhar 2002). Most seeds (99%) are dispersed within 50 m of the parent plant. Few seeds are deposited farther than 100 m (CDFA 2003) along travel and water corridors (Zouhar 2002). It is highly likely that seeds (sources of forage for birds and small rodents) are viable after consumed, based on viability after passing through other animal digestive systems (R. Lee, personal	

communication, 2003), and therefore have the potential for long distance dispersal. Holm and others (1997 in Beck 1999) stated <i>C. nutans</i> seeds have been found in the crops of birds and in their nests.
<b>Sources of information:</b> See cited literature; also considered personal communication with R. Lee (Weed Specialist, Bureau of Land Management, Denver, Colorado, 2004).

<b>Question 2.7</b> Other regions invaded	<i>Score: B Doc'n Level: Other pub.</i>
<b>Identify other regions:</b> Two other regions (Colorado and Utah) invaded that include ecological types not invaded in Arizona.	
<b>Rationale:</b> Subalpine community invaded in the Rocky Mountains (Beck 1999). Mountain brush communities also invaded (Welsh et al. 1987) that are equivalent to Great Basin montane scrub.	
<b>Sources of information:</b> See cited literature.	

<b>Question 3.1</b> Ecological amplitude	<i>Score: A Doc'n Level: Obs.</i>
<b>Describe ecological amplitude, identifying date of source information and approximate date of introduction to the state, if known:</b> Earliest record in Arizona's herbaria is 1952 Apache County, Ganado Dam (SEINet 2003). Introduced to North America during the period of 1853 to 1866 in Pennsylvania (Stuckey and Forsythe 1971 in Heidel 1987). Native to western and central Europe; restricted to temperate zones (Zouhar 2002).	
<b>Rationale:</b> Grows from sea level to about 2400 m (~8000 feet) in elevation and can survive with annual rainfall of 25 cm (Hull and Evans 1973 in Desrochers et al. 1988, Beck 1999). Beck (1999) states <i>C. nutans</i> has been found at elevations between 2743 to 3048 m (9000 and 10,000 feet). Its wide geographic range suggests there is not a specific climatic requirement (Desrochers et al. 1988). Invades open natural areas, such as meadows, grasslands (Moore and Frankton 1974 and Harris 1984 both in Desrochers et al. 1988). In the intermountain region of western North America, it occupies habitats ranging from saline soils to low altitude valleys to acidic soils at 8000 feet (Beck 1999). Most often associated with soils derived from limestone (Stuckey and Forsythe 1971, Batra 1978 in Heidel 1987); however, in the Great Basin and West this relationship does not necessarily hold true (Batra 1978 in Heidel 1987).	
Although plants are hardier where there is little competition, <i>C. nutans</i> also can grow in native and seeded ranges, irrigated pastures, and wet meadows with dense stands of graminoids (Hull and Evans 1973 in Zouhar 2002). Distribution of <i>C. nutans</i> is restricted mainly by extremes in soil water content, nutrient deficient or acid soils, and competition from other plant species (Australia: Doing and others 1969 in Desrochers et al. 1988). Several authors (see citations in Desrochers et al. 1988) report a minimal vernalization requirement for <i>C. nutans</i> of at least 40 days below 10 degrees C (50 F), which perhaps excludes it from dunes and the Mohave Desert.	
<b>Sources of information:</b> See cited literature. Also considered information from SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: <a href="http://seinet.asu.edu/collections">http://seinet.asu.edu/collections</a> ; accessed 2003).	

<b>Question 3.2</b> Distribution	<i>Score: D   Doc'n Level: Obs.</i>
<b>Describe distribution:</b> Mormon Lake, Lake Mary (western Arizona extent); Coconino National Forest (in ponderosa pine); Springerville (concentrated there in mainly irrigated pastures); Eagar, St. Johns, Little Colorado River (in prairie remnants/meadows); Navajo Reservation, near Ganado (in pinyon-juniper); and coming in through drainages and valleys from New Mexico; Chinle (D. Evans, personal communication, 2003). Montane riparian along the Little Colorado River (ottonwood, willow, herbaceous), shortgrass prairie, ponderosa pine, montane grasslands; populations on the Apache Sitgreaves are all associated with roads (M. White, personal communication, 2004). On the Arizona strip, occurs on Forest Service but not Bureau of Land Management land (L. Walker, personal communication, 2004).	

**Rationale:** By 1999 *C. nutans* was reported to occur in 45 states in the U.S. and all southern Canadian provinces (Kartesz 1999). Previous infestations in Mojave Desert (southeastern San Bernardino County) have been eradicated (CDFA 2003). Despite a fairly broad ecological amplitude, *C. nutans* does not exceed 5% frequency of occurrence within any ecological type that it invades (see Worksheet B).

**Sources of information:** See cited literature; also considered personal communications with D. Evans (Range Specialist, U.S. Department of Agriculture, Forest Service, Prescott National Forest, 2003), L. Walker (Weed Specialist, Bureau of Land Management, Arizona Strip, St. George, Utah, 2004), and M. White (Rangeland Ecologist, U.S. Department of Agriculture, Forest Service, Apache Site-Greaves National Forest, Springerville, Arizona, 2004), and Working Group member discussions. In addition, considered information from SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: <http://seinet.asu.edu/collections>; accessed 2003) and Southwest Exotic Plant Mapping Program (SWEMP) records (<http://www.usgs.nau.edu/SWEPIC/>) to assist in distribution assessment.

### Worksheet A. Reproductive Characteristics

Complete this worksheet to answer Question 2.4.

Reaches reproductive maturity in 2 years or less	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Dense infestations produce >1,000 viable seed per square meter	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	2 pt.
Populations of this species produce seeds every year.	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Seed production sustained for 3 or more months within a population annually	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Seeds remain viable in soil for three or more years	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	2 pt.
Viable seed produced with <i>both</i> self-pollination and cross-pollination	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Has quickly spreading vegetative structures (rhizomes, roots, etc.) that may root at nodes	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	1 pt.
Fragments easily and fragments can become established elsewhere	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	2 pt.
Resprouts readily when cut, grazed, or burned	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	1 pt.
<b>Total pts: 8 Total unknowns: 0</b>			
<b>Score : A</b>			

**Note any related traits:** *Carduus nutans* is an herbaceous biennial or occasionally winter annual or annual (Feldman et al. 1968 in Beck 1999). An average plant produces approximately 10,000 to 11,000 seeds/plant (McCarty and Scifres 1969 [cited in many different sources], McCarty 1982); however, only 1/3 of the seeds are viable (McCarty 1982). Holm and others (1997 in Beck 1999) report seed production per plant to range from a few thousand to more than 100,000. Sindel 1991 (in Zouhar 2002) reported *C. nutans* can produce flowers and seeds throughout the growing season if soil moisture levels are adequate. Noted elsewhere, the growing season for *C. nutans* is May to September depending on location, habitat, and environmental conditions (various authors), but in New Mexico flowering occurs July to August (Martin and Hutchins 1981 in Zouhar 2002). Flowers over a 7 to 9 week period (Beck 2003). Seed can remain viable for over 10 years (Burnside et al. 1981 in Heidel 1987, Beck 1999, Desrochers et al. 1988).

Root crown needs to have high severity fire to kill *C. nutans*; if only scared, they can bolt and bloom (observed in Nebraska; reviewed by Heidel 1987). Fire has been used as a control mechanism (see Zouhar 2002). Seed production and seedling establishment are enhanced under disturbed conditions (Beck 1999). Can out-cross and self pollinate (McCarty 1982, Popay and Medd 1990, and Beck 1999 all in Zouhar 2002). Seeds germinate at high rates in soil cracks or rough microtopographies with reduced evaporation (Zouhar 2002).

**Worksheet B. Arizona Ecological Types**

(sensu Brown 1994 and Brown et al. 1998)

Major Ecological Types	Minor Ecological Types	Code*
<b>Dunes</b>	dunes	
<b>Scrublands</b>	Great Basin montane scrub	
	southwestern interior chaparral scrub	
<b>Desertlands</b>	Great Basin desertscrub	<b>D</b>
	Mohave desertscrub	
	Chihuahuan desertscrub	
	Sonoran desertscrub	
<b>Grasslands</b>	alpine and subalpine grassland	<b>D</b>
	plains and Great Basin shrub-grassland	<b>D</b>
	semi-desert grassland	
<b>Freshwater Systems</b>	lakes, ponds, reservoirs	
	rivers, streams	
<b>Non-Riparian Wetlands</b>	Sonoran wetlands	
	southwestern interior wetlands	
	montane wetlands	
	playas	
<b>Riparian</b>	Sonoran riparian	
	southwestern interior riparian	<b>D</b>
	montane riparian	<b>D</b>
<b>Woodlands</b>	Great Basin conifer woodland	<b>D</b>
	Madrean evergreen woodland	<b>D</b>
<b>Forests</b>	Rocky Mountain and Great Basin subalpine conifer forest	
	montane conifer forest	<b>D</b>
<b>Tundra (alpine)</b>	tundra (alpine)	

\*A means >50% of type occurrences are invaded; B means >20% to 50%; C means >5% to 20%; D means present but ≤5%; U means unknown (unable to estimate percentage of occurrences invaded).

Elevation ranges below provided in the Fire Effects Information System (available online at: <http://fs.fed.us/database/feis/plants>). Arizona and specific plant communities are not listed.

Location	Elevation Range	Reference
California	330 to 3,960 feet (100 to 1,200 m)	Hickman (1993)
Colorado	9,000 to 10,000 feet (2,700 to 3,000 m)	Holm et al. (1997) in Beck (1999)
New Mexico	4,500 to 8,500 feet (1,400 to 2,600 m)	Martin and Hutchins (1981)
Utah	4,400 to 8,100 feet (1,340 to 2,440 m)	Welsh et al. (1999)



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